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applied to the last result, give after simplifications,

$$\{(M+m)R^2 + Mk'^2\}\ddot{\varphi} - mRr'\cos(\theta-\alpha)\ddot{\theta} + mRr'\sin(\theta-\alpha)\dot{\theta}^2 = g(M+m)R\sin\alpha,$$

$$Rr'\cos(\theta-\alpha)\ddot{\varphi} - (r'^2 + k'^2)\ddot{\theta} = gr'\sin\theta.$$

Eliminating  $\ddot{\varphi}$ ,

$$\begin{aligned} & [(r'^2 + k'^2)\{(M+m)R^2 + Mk'^2\} + mR^2r'^2\cos^2(\theta-\alpha)]\ddot{\theta} - mR^2r'^2\sin(\theta-\alpha)\cos(\theta-\alpha)\dot{\theta}^2 \\ & = -gr'[(\{(M+m)R^2 + Mk'^2\}\sin\theta + (M+m)R^2\sin\alpha\cos(\theta-\alpha)]. \end{aligned}$$

Multiplying by  $2\dot{\theta}$  and integrating

$$\begin{aligned} & [(r'^2 + k'^2)\{(M+m)R^2 + Mk'^2\} + mr'^2R^2\cos^2(\theta-\alpha)]\dot{\theta}^2 \\ & = gr'[2\{(M+m)R^2 + Mk'^2\}\cos\theta - 2(M+m)R^2\sin\alpha\sin(\theta-\alpha)] + C', \end{aligned}$$

which is of the same general form as (7), p. 351, this MONTHLY for November, 1916.

#### NUMBER THEORY.

##### 235. Proposed by W. D. CAIRNS, Oberlin College.

Prove that  $n = 1$  is the only positive integer for which  $n^4 + 4$  is a prime.

SOLUTION BY WM. E. PATTEN, Government Institute of Technology, Shanghai, China.

$$n^4 + 4 = (n^4 + 4n^2 + 4) - 4n^2 = (n^2 + 2)^2 - (2n)^2 = (n^2 + 2n + 2)(n^2 - 2n + 2).$$

Therefore,  $n^4 + 4$  is a prime, if at all, only for those values of  $n$  which make either  $n^2 + 2n + 2 = 1$ , or  $n^2 - 2n + 2 = 1$ , since each of the factors of  $n^4 + 4$  given above is integral in value when  $n$  is integral, and both are positive when  $n$  is positive.

(1) When  $n^2 + 2n + 2 = 1$ , then  $n = -1$ .

(2) When  $n^2 - 2n + 2 = 1$ , then  $n = +1$ . When  $n = +1$ , then  $n^4 + 4 = 5$ , a prime.

Therefore,  $n^4 + 4$  is a prime for  $n = 1$ , and for no other positive integral values of  $n$ .

Also solved by ELMER SCHUYLER, FRANK IRWIN, HORACE OLSON, ELIJAH SWIFT, H. H. CLARK, ELIZABETH B. DAVIS, NORMAN ANNING, L. G. WELD, and the PROPOSER.

##### 236. Proposed by V. M. SPUNAR, Chicago, Illinois.

Find integral values of  $x, y, z$ , such that

$$xy + z = \square, \quad yz + x = \square, \quad \text{and} \quad xz + y = \square.$$

SOLUTION BY ARTEMAS MARTIN, LL.D., Washington, D. C.

Assume  $x = n^2$ ,  $y = (n+1)^2$ ; then the given equation becomes

$$n^2(n+1)^2 + z = \square, \quad (n+1)^2z + n^2 = \square, \quad n^2z + (n+1)^2 = \square.$$

Put

$$n^2(n+1)^2 + z = a^2.$$

Assume  $a = n^2 + n + b$ , and the last equation becomes

$$n^2(n+1)^2 + z = a^2 = (n^2 + n + b)^2,$$

from which we immediately find

$$z = b(2n^2 + 2n + b).$$

Substituting in

$$(n+1)^2z + n^2 = \square,$$

we have

$$b(n+1)^2(2n^2 + 2n + b) + n^2 = \square = c^2,$$